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The MONTHLY REVIEW

Published Monthly by the

American Electro-Platers Society

A SOCIETY FOR THE ADVANCEMENT

OF THE

SCIENCE OF ELECTROPLATING

MAY, 1932

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MONTHLY REVIEW

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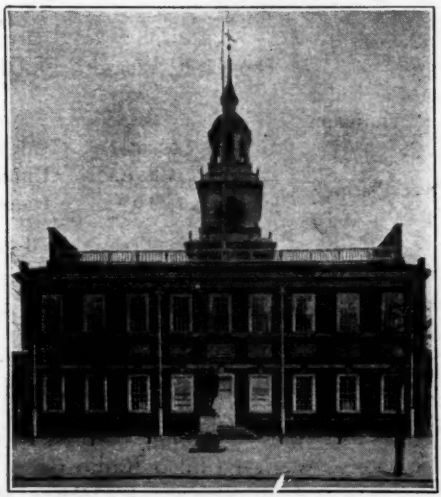
VOL. XIX MAY, 1932 No. 5

Philadelphia Convention

BENJAMIN FRANKLIN HOTEL

June 20, 21, 22 and 23, 1932



Courtesy Conventions and Exhibition Bureau Philadelphia Chamber of Commerce

INDEPENDENCE HALL

Headquarters and Registration will be at the Benjamin Franklin Hotel, 9th and Chestnut Streets, Philadelphia, Pa.

Registration will begin on Sunday afternoon, June 19. The Registration Committee will receive arriving members and guests and give detailed information.

The Technical division chairman, Dr. Lukens, has arranged for some highly technical papers, some of which are listed below:

Electrodeposition of Tungsten from Alkaline Solutions, by Dr. L. Kahlenberg and M. L. Holt, of the University of Wisconsin.

Peeling of Electrodeposited Nickel, by E. A. Vuilleuvnier, of Dickerson College.

Review of Recent Foreign Literature Relating to Electroplating, by M. deKay Thompson, of the Massachusetts Institute of Technology.

Dr. A. K. Graham, chairman of the Industrial division, has also arranged for a symposium on Zinc, with the following speakers and papers:

Title	*Author*	*Company*
"Plating of Zinc Base Die Castings"	R. J. WIRSHING	General Motors
"Plating on Zinc"	W. M. PEIRCE	N. J. Zinc Co.
"Electroplating Zinc on Aluminum"	HAROLD K. WORK	Aluminum Co. of A.
"Barrel Plating—Particular Reference to Optimum Loads and Costs"	GUSTAF SODERBERG	Udylite Process Co.
"Anodes for Zinc Plating"	DR. A. K. GRAHAM	University of Penna.
	G. B. HOGABOOM	Hansen-Munning Co.

Lieut. Arthur Willink of the U. S. Arsenal will deliver a paper on A Study of Base Metals in Industrial Chromium Plating Applications.

There will be plant visits to the following industrial plants:

General Electric Co.	Delong Hook & Eye Co.
Steel Heddle Co.	Philco Radio Corp.
Gottschalk Co.	R. C. A. Victor Radio Co.
Navy Yard, Air Craft Division	Atwater-Kent Radio Co.

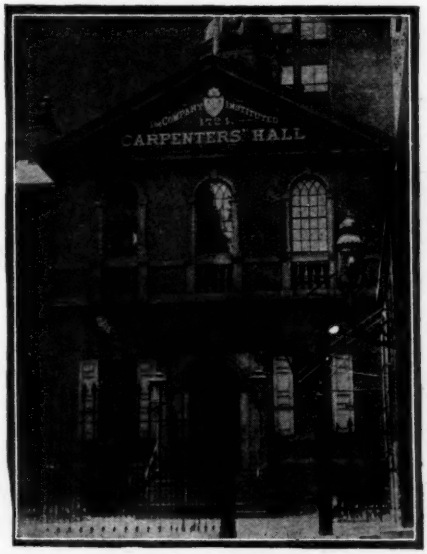
There will also be trips to the University Museum, where there will be exhibits of Bronzes which were restored by an electroplating process.

Trips to places of Historical and Traditional interest have been arranged for. A more complete programme will appear in the June issue.

In last month's Review we asked the members to send in their names and addresses, together with their firms' or business address, so we could send everyone interested an invitation letter as instructed by the minutes of our previous conventions.

Up to date, only three members have answered the request. How under the sun can you expect your officers and committees to function properly when you will not respond to such a small request? Now don't let it be said that our members lack the spirit of coöperation, but send in the names of your firms to Geo. Gehling, 5001 Tulip Street, Philadelphia, Pa. Do it today and give the Society the opportunity to accomplish something as it should.

GEO. GEHLING, *Convention Director.*



Courtesy Conventions and Exhibitions Bureau
Philadelphia Chamber of Commerce

CARPENTERS' HALL

REPORT ON THE PREPARATION OF SPECIMENS FOR EXPOSURE TESTS OF ELECTROPLATED COATINGS ON STEEL*

By
Joint Committee of American Electroplaters' Society, American Society for Testing Materials and the Bureau of Standards

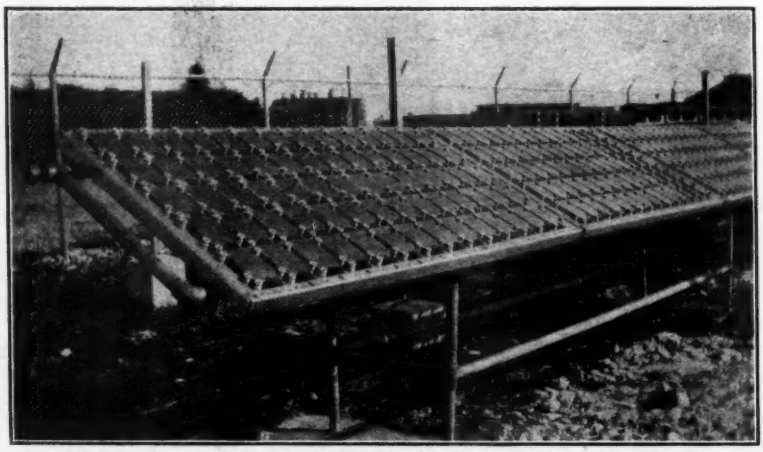
I. General Plan

All specimens were prepared at the Bureau of Standards by the Research Associate of the American Electro-Platers Society, with the assistance of the Bureau staff, and will be exposed through coöperation with the A.S.T.M.

The exposure tests will be started in the spring, 1932, at Sandy Hook, N. J.; Bell Laboratories, New York City; Pennsylvania State College; Pittsburgh, Pa.; Washington, D. C.; and Key West, Fla. Five specimens of each kind will be exposed in each location. These samples will be inspected at regular intervals by members of the joint committee consisting of:

Jacob Hay, Walter Fraine, A. K. Graham, W. M. Phillips, R. F. Passano, L. H. Rovere, and W. Blum, Chairman.

Notices of these inspection trips will be sent to the coöperating firms listed in this report and to others who request the Chairman for such notices. Any interested persons may be present at these inspections, with the understanding that they will not use any



Racks for Exposure of Electroplated Samples at Key West, Florida. In each location there are eight racks, each holding 70 specimens.

*Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

information obtained at that time for publication or for advertising purposes.

Corresponding samples will be subjected to laboratory tests, including accelerated corrosion, to determine the relation of these results to atmospheric exposures. The results of these exposure and laboratory tests will not be published until definite conclusions can be reached by the inspection committee.

In general, a certain arbitrarily selected "standard" procedure for cleaning and plating was employed as a basis of reference, without any implication that such a procedure is necessarily superior. Some important step in the process was then varied over sufficiently wide limits to determine whether such a change produces a definite effect upon the protective value of the coatings. The samples include steel finished with nickel, chromium, zinc or cadmium, in some cases preceded by preliminary coatings.

II. Conditions Used

In the following outline, the conditions used are briefly defined. No attempt has been made to give exact equivalents of metric and English units. Most of the laboratory measurements were metric. The thicknesses of deposits are here expressed only in English units, but the final reports may include both.

1. *Cleaning Procedure:*

A—Standard—The plates were treated as follows:

(1) The surface grease was removed with amyl acetate and carbon tetrachloride.

(2) Cathode electrolytic cleaning was used.

Solution Formula

	N	g/l	oz/gal
Sodium carbonate, Na_2CO_3	0.6	30	4
Trisodium phosphate, $Na_3PO_4.12H_2O$	0.25	30	4
Sodium hydroxide, NaOH	0.2	7.5	1

Temp. = 194°F (90°C). A current density of about 47 amp/sq. ft. (5 amp/dm^2) was applied for 5 minutes.

(3) Scrubbed with a bristle brush wet with the same cleaning solution.

(4) Rinsed in hot water.

(5) Pickled in sulphuric acid. 2 *N* solution (containing about 10 per cent by weight of H_2SO_4) at 122°F (50°C) for 2 minutes.

(6) Rinsed in cold water.

A-1—(Hot Alkali Dip). The procedure was the same as in A, except that after (6) the plates were immersed for 5 minutes, without current, in the hot cleaning solution, scrubbed and rinsed.

B—Cathode Pickling—The same procedure was used as in A, except that in (5) the steel was pickled as cathode in 2 *N* H_2SO_4 at 122°F (50°C) and 19 amp/sq. ft. (2 amp/dm²) for 2 minutes, and lead anodes were used.

C—Anode Pickling—The same procedure was used as in A, except that following (5) the steel was pickled as anode in 96 per cent sulphuric acid at 70°F (22°C) and 12 volts, with lead as the cathode, until the current dropped to a minimum.

2. *Conditions for Nickel-Plating:*

Rolled nickel anodes (99+ per cent) were used. The operating conditions were as follows:

E—Standard—

Solution Formula	N	g/l	oz/gal
Nickel sulphate, $NiSO_4.7H_2O$	1.4	200	27
Nickel chloride, $NiCl_2.6H_2O$	.4	45	6
Boric acid, H_3BO_3	0.5M	30	4

pH=5.3 (Quinhydrone, or colorimetric corrected)
Temp.=95°F (35°C)
Current density=19 amp/sq. ft. (2 amp/dm²)

E-1—High Temperature
Solution formula and pH same as E.
Temp.=140°F (60°C)
Current Density=37 amp/sq. ft. (4 amp/dm²)

F—Low pH—
Solution formula same as E.
pH=2.5 (Quinhydrone, or colorimetric corrected)
Temp.=140°F (60°C)
Current Density=37 amp./sq. ft. (4 amp/dm²)

F-1—The solution formula and pH were the same as in F.
Temp.=122°F (50°C)
Current Density=47 amp/sq. ft. (5 amp/dm²)

G—For Plating Nickel Over Zinc or Cadmium Coatings—

Solution Formula	N	g/l	oz/gal
Nickel sulphate, $NiSO_4.7H_2O$	1.0	140	19
Ammonium chloride, NH_4Cl	0.25	15	2
Sodium sulphate, Na_2SO_4	2.0	140	19
Boric acid, H_3BO_3	0.25	15	2

pH=5.7 (Quinhydrone, or colorimetric corrected)
Temp.=70°F (22°C)
Current Density=19 amp/sq. ft. (2 amp/dm²)

3. *Conditions for Chromium Plating:*

Lead anodes containing 6 per cent of antimony were used. The operating conditions were as follows:

I—Standard—

Solution Formula		g/l	oz/gal
Chromic acid, CrO_3	2.5M	250	33
Sulphuric acid, H_2SO_4	.05*N*	2.5	0.33

Temp.=113°F (45°C)
Current Density=150 amp/sq. ft. (16 amp/dm²)

I-1—Solution formula as in I
Temp.=95°F (35°C)
Current Density=75 amp/sq. ft. (8 amp/dm²)

I-2—Solution formula as in I
Temp.=130°F (55°C)
Current Density=250 amp/sq. ft. (27 amp/dm²)

I-3—Solution formula as in I
Temp.=150°F (65°C)
Current Density=350 amp/sq. ft. (38 amp/dm²)

J—Solution with low sulphate content

Solution Formula		g/l	oz/gal
Chromic acid, CrO_3	2.5M	250	33
Sulphuric acid, H_2SO_4	0.025 *N*	1.25	0.17

Temp.=113°F (45°C)
Current Density=150 amp/sq. ft. (16 amp/dm²)

K—Solution with high chromic acid content

Solution Formula		g/l	oz/gal
Chromic acid, CrO_3	4 M	400	53
Sulphuric acid, H_2SO_4	0.08 *N*	4	0.53

Temp.=113°F (45°C)
Current Density=150 amp/sq. ft. (16 amp/dm²)

K-1—Solution formula as in K
Temp.=130°F (55°C)
Current Density=250 amp/sq. ft. (27 amp/dm^2)
K-2—Solution formula as in K
Temp.=150°F (65°C)
Current Density=470 amp/sq. ft. (50 amp/dm^2)

4. *Conditions for Copper Plating:*
Rolled copper anodes were used. The operating conditions were as follows:

L—Cyanide Copper—

Solution Formula	N	g/l	oz/gal
Copper cyanide, CuCN	0.25	22.5	3
Sodium cyanide, NaCN	0.65	34	4.5
Sodium carbonate, Na_2CO_3	0.30	15	2
(Resultant free sodium cyanide)	0.15	7.5	1

Temp.=120°F (50°C)
Current Density=14 amp/sq. ft. (1.5 amp/dm^2)

M—Acid Copper—

Solution Formula	N	g/l	oz/gal
Copper sulphate, $CuSO_4.5H_2O$	2	250	33
Sulphuric acid, H_2SO_4	1.5	75	10

Temp.=95°F (35°C)
Current Density=23 amp/sq. ft. (2.5 amp/dm^2)

5. *Conditions for Zinc Plating:*
Cast zinc anodes were used. The operating conditions were as follows:

N—Cyanide Bath—Standard—

Solution Formula	N	g/l	oz/gal
Zinc cyanide, $Zn(CN)_2$	1.0	60	8
Sodium cyanide, NaCN	0.5	23	3
Sodium hydroxide, NaOH	1.3	53	7

Temp.=70°F (22°C)
Current Density=19 amp/sq. ft. (2 amp/dm^2)

O—Cyanide Bath—With Mercury—
The solution formula was the same as in N, with addition of mercuric oxide equivalent to 1 per cent of the zinc content. (Zinc anodes were used, and the necessary additions of mercuric oxide were made to the baths.)
Temp.=70°F (22°C)
Current Density=19 amp/sq. ft. (2 amp/dm^2)

P—Acid Bath—High Sulphate—

Solution Formula	N	g/l	oz/gal
Zinc sulphate, $ZnSO_4.7H_2O$	3	410	54
Sodium sulphate, Na_2SO_4	1	75	10
Aluminum chloride, $AlCl_3.6H_2O$	0.25	20	3

pH=3 to 4 (Quinhydrone, or colorimetric corrected)
Temp.=95°F (35°C)
Current Density=47 amp/sq. ft. (5 amp/dm²)

Q—Acid Bath—Organic Addition Agent—
The solution formula was the same as in P, except that dextrin (7.5 g/l or 1 oz/gal) was substituted for the sodium sulphate. The conditions were the same as in P.

6. *Conditions for Cadmium Plating:*
Cast cadmium anodes were used. The operating conditions were as follows:

R—Standard—

Solution Formula	N	g/l	oz/gal
Cadmium oxide, CdO	0.35	23	3
Sodium cyanide, NaCN	1.5	75	10
Sodium hydroxide, NaOH	0.4	15	2

Temp.=70°F (22°C)
Current Density=9 amp/sq. ft. (1 amp/dm²)

S—With "Gulac" as Addition Agent—

Solution Formula	N	g/l	oz/gal
Cadmium oxide, CdO	0.7	45	6
Sodium cyanide, NaCN	2.5	120	16
Gulac		12	1.6

Temp.=70°F (22°C)
Current Density=19 amp/sq. ft. (2 amp/dm²)

T—With Gulac and Nickel as Addition Agents
The solution formula was the same as in S, with the addition of 1 g/l of nickel sulphate, ($NiSO_4.7H_2O$)
Temp.=70°F (22°C)
Current Density=19 amp/sq. ft. (2 amp/dm²)

7. *Conditions for Plating Zinc-Cadmium Alloys:*
U—Anodes containing 90 per cent of zinc and 10 per cent of cadmium were used to produce deposits with approximately 10 per cent cadmium.

Solution Formula	N	g/l	oz/gal
Zinc cyanide, $Zn(CN)_2$	1.2	75	10
Cadmium oxide, CdO	0.05	3	0.4
Sodium cyanide, NaCN	0.75	38	5
Sodium hydroxide, NaOH	2.25	90	12

Temp.=95°F (35°C)

Current Density=19 amp/sq ft. (2 amp/dm^2)

U-1—The cadmium content of the solution was reduced to produce deposits with about 5 per cent of cadmium.

U-2—The cadmium content of the solution was increased to produce deposits with about 15 per cent of cadmium.

III. Schedule of Deposits

All thicknesses in inches

1—NICKEL FINISH

Expt.	*Cleaning*	*Preliminary Metal*	*Preliminary Method*	*Preliminary Plating Thick*	*Nickel Method*	*Nickel Plating Thick*	*Variation*
1	A	....	....	....	E	0.001*	Standard
2	B	....	....	....	E	.001*	Cathode pickle
3	C	....	....	....	E	.001*	Anode pickle
4	A	....	....	....	E-1	.001*	High temp., high pH
5	A	....	....	....	E	.0005*	Half thickness
6	A	....	....	....	E	.002*	Double thickness
7	A	....	....	....	F	.001*	Low pH
9	A	Cu	L	0.0005	E	.0005*	Cu(CN), Ni
10	A	Cu	L	.0005*	E	.0005*	Cu*(CN), Ni
11	A	Cu Cu	L M	.0001 .0004	E	.0005*	Cu(CN), Cu (acid), Ni
12	A	Cu Cu	L M	.0001 .0004*	E	.0005*	Cu(CN), Cu* (acid), Ni
13	A	Cu	M	.0003	E	.0002 .0005*	Ni,Cu (acid), Ni
14	A	Cu	L	.0003	E	.0002 .0005*	Ni,Cu(CN),Ni
15	A	Cu	M	.00015	E	.0001 .00025*	No. 13, half thickness
16	A	Cu	M	.0006		.0004 .001*	No. 13, double thickness
17	A	Cu	M	.0003	F-1	.0002 .0005*	No. 13, with Ni at low pH
18	A	Cu	M	.0003	E	.0002 .0005*	No. 13, heated 30 min. to 200°C

*Buffed.

Expt.	Cleaning	Preliminary Plating Metal	Method	Thick	Nickel Plating Method	Thick	Variation
19	A	Cu	M	.0003	F-1	.0002 .0005*	Low pH and heated 30 min. to 200°C
21	A	Zn	N	.0005	G	.0005*	Zn, Ni
23	A	Cd	T	.0005	G	.0005*	Cd, Ni
24	A	Zn Cu	N L	.0002 .0003	E	.0005*	Zn, Cu, Ni
25	A	Cd Cu	T L	.0002 .0003	E	.0005*	Cd, Cu, Ni
51	A	....	....	....	E	.001	Standard, not*
52	A	....	....	....	E	.00025*	Standard, ¼ thick
53	A	Cu	M	.00008	E	.00005 .00013	No. 13, ¼ thick

2—CHROMIUM FINISH

Expt.	Cleaning	Preliminary Plating as in Expt. No.	Chromium Plating Method	Thick	Variation
101	A	1	I	0.00002	Ni-Standard
102	B	2	I	.00002	Ni-Cathode pickle
103	C	3	I	.00002	Ni-Anode pickle
104	A	4	I	.00002	Ni-High temp., high pH
105	A	5	I	.00002	Ni, 0.0005
106	A	6	I	.00002	Ni, 0.002
107	A	7	I	.00002	Ni, low pH
109	A	9	I	.00002	Cu(CN), Ni
110	A	10	I	.00002	Cu*(CN), Ni
111	A	11	I	.00002	Cu(CN), Cu(acid), Ni
112	A	12	I	.00002	Cu(CN), Cu*(acid), Ni
113	A	13	I	.00002	Ni,Cu(acid), Ni
114	A	14	I	.00002	Ni, Cu(CN), Ni
115	A	15	I	.00002	Ni,Cu(acid),Ni(0.0005)
116	A	16	I	.00002	Ni,Cu,Ni (0.002)
117	A	17	I	.00002	Ni, Cu, Ni, low pH
118**	A	18	I	.00002	Ni, Cu, Ni, heated
119**	A	19	I	.00002	Ni, Cu, Ni, low pH, heated
121	A	21	I	.00002	Zn, Ni
123	A	23	I	.00002	Cd, Ni
124	A	24	I	.00002	Zn, Cu, Ni
125	A	25	I	.00002	Cd, Cu, Ni
126	A	13	I	.00001	Thickness of Cr
127	A	13	I	.00003	Thickness of Cr
128	A	13	I	.00005	Thickness of Cr
129	A	13	I-1	.00002	Cr at 35°C
130	A	13	I-2	.00002	Cr at 55°C
131	A	13	I-3	.00002	Cr at 65°C
132	A	13	J	.00002	CrO_3/SO_4 ratio=200

*Buffed

**Heated after chromium plating.

Expt.	Cleaning	Preliminary Plating as in Expt. No.	Chromium Plating Method	Thick	Variation
133	A	13	K	.00002	400 g/l CrO_3
134	A	None	I	.0002	Direct Cr thick
135	A	None	I-2	.0002	Cr at 55°C
136	A	None	I-3	.0002	Cr at 65°C
137	A	Cd*,S,0.0005	I-1	.00002*	Cd, Cr
138	A	Zn*,N, .0005	I-1	.00002*	Zn, Cr
152	A	52	I	.00002	Ni (0.00025)
153	A	53	I	.00002	Ni,Cu,Ni (0.00025)
154	A	13	I	.0001	Thickness of Cr
155	A	13	K-1	.00002	400 g/l CrO_3, 55°C
156	A	13	K-2	.00002	400 g/l CrO_3, 65°C

3—ZINC FINISH

Expt.	Cleaning	Zinc Plating Method	Thick	oz/sq.ft.***	Variation
201	A-1	N	0.0005	0.59	Standard cyanide
202	B, A-1	N	.0005	.59	Cathode pickle
203	C	N	.0005	.59	Anode pickle
205	A-1	N	.0002	.24	Thickness
206	A-1	N	.001	1.18	Thickness
207	A-1	O	.0002	.24	Cyanide + mercury
208	A-1	O	.0005	.59	Cyanide + mercury
209	A-1	O	.001	1.18	Cyanide + mercury
210	A	P	.0005	.59	Acid, high sulphate
214	A	P	.0002	.24	Thickness
215	A	P	.001	1.18	Thickness
216	A-1	Q	.0002	.24	Acid, organic addition
217	A-1	Q	.0005	.59	Thickness
218	A-1	Q	.001	1.18	Thickness
219	Hot galvanized		.0009	1.05	Hot dipped

4—CADMIUM FINISH

Expt.	Cleaning	Cadmium Plating Method	Thick	Variation
301	A	R	0.0005	Standard
302	B	R	.0005	Cathode pickle
303	C	R	.0005	Anode pickle
304	A	R	.0002	Thickness Cd
305	A	R	.001	Thickness Cd
307	A	S	.0002	Gulac brightener
308	A	S	.0005	Thickness Cd
309	A	S	.001	Thickness Cd
310	A	T	.0002	Ni and gulac brightener
311	A	T	.0005	Thickness Cd
312	A	T	.001	Thickness Cd

*Buffed.

***Total weight for both sides.

5—ZINC-CADMIUM ALLOY FINISH

Expt.	Cleaning	Alloy Plating Method	Thick	Variation
401	A	U	0.0005	10 per cent Cd
402	A	U	.0002	Thickness
403	A	U	.001	Thickness
404	A	U-1	.0005	5 per cent Cd
405	A	U-2	.0005	15 per cent Cd

MATERIALS USED IN THIS INVESTIGATION

I—*Strip Steel:*

Over 6000 specimens, 4" x 6", were plated, including those to be used in laboratory tests. Cold rolled strip steel with selected good finish, 22 U.S. gage (0.031"); S.A.E. 1010 (approximately 0.1 per cent carbon), was donated by the American Steel & Wire Co.

II—*Exposure Racks and Frames:*

Material for 48 sample racks, each holding 70 samples, was donated by the American Sheet and Tin Plate Co.

Galvanized pipe and fittings required for the supports were donated by the Reading Iron Co. and the Crane Co. All labor costs for the construction of these racks and supports were paid by the A.S.T.M.

III—*Plating Equipment:*

All generators, tanks, plating racks, etc., were furnished by the Bureau of Standards.

The anodes, chemicals and buffing materials were donated by the following firms:

Grasselli Chemical Co.
Hanson-Van Winkle-Munning Co.
Harshaw Chemical Co.
International Nickel Co.
Roessler and Hasslacher Chemical Co.
Udylite Process Co.

HOT NICKEL SOLUTIONS AND LOW pH

By Alex. Regmunt
Member Los Angeles Branch, delivered at the Third Annual Educational Session, March 12, 1932

In presenting this paper it is my purpose to outline the methods I have employed in plating bumper bars, and which perhaps can be applied to other products with equal success.

All my plating racks are so designed that the work to be plated is not "shaded," and preferably so that it is unnecessary to shift

any work on the plating rack during the process of plating. Bars containing eyes are racked by a rod running through the eyes of the bars and with small spacers placed between successive bars so that the edges of these are about one-half inch apart. With very wide or very thick bars this spacing is increased in order to get proper current distribution. The rods on which the bars are racked are suspended from the cathode bars by a casting, so designed as to bring to the center of the cathode bars. It is often desirable to have a rubber bar that conforms to the shape of bars or fender guards that can be placed on the bottom and the top of the rods as racked up. These are made of low carbon steel rods about one-fourth inch in diameter. It is also usually advantageous to provide rubber rods or bars to take care of any sharp edges, on which burning or rough deposits are obtained without this protection. All rubber bars are discarded when they have become rough, or when they become unduly large as a result of the plating, even though they may still remain smooth. Excessively built-up rubber bars are expensive, as they both take more current and plate than they should, and also carry too much solution from the plating tanks to the rinse tank.

The work on the plating racks is placed in the first cleaner for a period of not less than two minutes. A longer cleaning time is not detrimental. This cleaner may be agitated by air, and operated at a minimum temperature of 190 degrees F. and preferably boiling. This may be operated as an electrolytic cleaner, with the work the cathode.

We transfer the work directly from the first cleaner to a second cleaner for a like period of time. The use of air agitation is optional. This must be an electrolytic cleaner, the work being made the cathode only, and the highest currents available should be used. The operating temperatures are the same as for the first cleaner.

Following these cleaning operations we rinse in a spray tank, and in the event the plating tank is not empty, we place the racks in a storage tank of clear, flowing water.

We then immerse the racks in a muriatic acid dip for 30 seconds and rinse in spray.

I desire to mention here that this Spray Rinse does not permit of any accumulation of contamination in the water because there is no water in the tank since the flow of the water from the spray immediately goes to the sewer.

My first nickel tank is a strike and the work is lowered into the tank and the current turned on either instantly or within thirty seconds after placing the work in the tank. However, if the rinse water is very cold, it may be necessary to allow 6 to 15 seconds for the work to come to the temperature of the bath before turning on the current. The time required for the plating depends upon the current density in amperes which should be 200 ampere minutes per square foot of work. Thus, if the current density is 50 amperes per square foot, the plating time should be four minutes, and if the current density may be regulated by the voltage, which is impressed upon the plating tank, the distance between the anodes, and the temperature of the plating solution. The normal temperature for this solution is 115 degrees to 125 degrees F. Air agitation is not used while plating.

Rinse in spray stall.

Work after removal from the flash nickel tank is quickly rinsed to prevent drying. The strike is followed with copper, the operation and the control of current density being similar to that in nickel. The plating is continued for 300 ampere minutes with a current density of 40 to 100 amperes per square foot. A time of 6 minutes and a current density of 50 is recommended. The normal temperature for this solution is 70 to 85 degrees F. This solution must be very vigorously air agitated at all times.

The air header and the pipe connected to this air header may occasionally become clogged with dry copper sulfate which works back from the copperplating tank when the air agitation is shut off. It is therefore necessary from time to time to take these pipes apart and clean them in order to maintain a proper agitation of the copperplating solution. If the installation permits water to be passed into the tank through the air agitator pipes, these deposits are readily washed away.

Rinse in spray stall.

After buffing, the work is given a final nickel-plating and this is at 400 ampere minutes per square foot of work, at a current density of 35 amperes per square foot and a time of 11½ minutes at a normal temperature of 115 degrees F.

Rinse in spray stall, then rinse in hot water and unrack.

This operation consists in rinsing the work in a tank of hot water. The work is left in the hot water only a few seconds, this tank must be kept at a temperature of about 200 degrees F. On the

other hand, if the work is left in the tank for about five minutes, a much lower temperature will suffice. At the lower temperatures, there will be much less steam given off into the room, and the working conditions will be better. The work on the removal from the hot water tank should dry promptly and be transferred on to the racks on which it entered the Plating Department, and is then transferred to the Buffing Department.

In making up our solutions, one pint sample is taken of every new solution after it is made up. This is well labeled and preserved until after analysis. Records are kept of the analysis of all new solutions as made up.

In making up my cleaners I use two ounces of metal cleaner per gallon of cleaning solution in each tank. A small quantity of water is added, and the mixture boiled and well stirred. More water to make up the volume is then added and boiling continued.

Muriatic Acid Dip.

This solution is used as a dip. It is made up by adding one gallon of 18 degrees Bé. Muriatic Acid to two gallons of water. After the addition, this solution is well stirred, and the gravity measured at 60 to 70 degrees F. should be about 6 degrees Bé. and the solution should analyze 2 to 3 normal in acid.

This solution is tested qualitatively for the presence of copper. This may be done by placing some freshly polished steel in a beaker containing this solution. If copper is present it will appear as metallic copper on the steel, and in that case a new solution is substituted for the old, if peeling of the nickel plate from the steel is to be avoided.

Nickel-Plating Solution.

The same solutions are used for flash and final nickel-plating. The nickel-plating solution is made up by dissolving 45 ounces of nickel sulphate (containing 21.5% metallic nickel, which is the usual grade), 3 to 4 ounces of nickel chloride and 4 ounces of boric acid per gallon of solution. Since the nickel-plating tanks are provided with heating coils and air agitation, all of these materials may be dumped together into the tank which has been half-filled with water, and brought into the solution by boiling and with the aid of air agitation. The water is added to bring the solution to the proper level, and the solution again boiled and agitated. The solution is then neutralized, filtered and reacidified, measured at 60 to 70 degrees F., should be about 26 degrees Bé.

Acid copperplating solution.

This solution is made up by dissolving 28 ounces of copper sulfate per gallon, and then adding 11 ounces of 66 degrees Bé. sulfuric acid per gallon of solution. It is desirable but not necessary to boil the mixture to aid in dissolving the copper sulfate. The gravity of the solution measured at 60 degrees F. should be 22.0 degrees Bé. After the solution is made up, one quart of "Red Hen" molasses is added to each 1000 gallons of solution.

Cleaning solutions are maintained on the basis of both analysis and performance. The total alkalinity should be not less than 0.2 normal and not more than 0.5 normal.

As the chemical analysis, however, is no criterion of the amount of grease which may be suspended in the cleaner, chemical analysis does not furnish a complete control. Upon the judgment of the operator, additions will have to be made to the cleaning solutions from time to time. Any metal cleaner or caustic soda in amounts of one-fourth to one-half ounce per gallon will usually restore the solution to effective cleaning. As a result of such additions, the solution will gradually become more and more concentrated. When the alkalinity gas becomes too high, it is advisable to dump the solution, and make up a new solution. However, if this point is reached when production demands do not allow time for making up a new cleaner, water is added to the solution, which may thus be diluted and caused to overflow the tank. Subsequent additions of metal cleaner or caustic soda, or both, should then restore the bath to effective working condition.

Failure of the cleaning solutions to give work which is thoroughly free from water break is a clear indication that they need attention.

Muriatic Acid Dip. This solution on analysis should show total acid—2.0 to 3.0 normal.

If low, more muriatic acid should be added. A 1.0 normal solution contains about 1.08 lbs. muriatic acid per gallon.

Nickel-Plating Solutions. These solutions on analysis show: acidity by colorimeter between 3.5 and 5.7, and preferably between 4.0 and 4.5.

Nickel (metallic)	=	2.50 normal
Chloride	=	0.21 normal
Boric Acid	=	0.45 normal

These solutions are tested at least twice daily with the colorimeter. If the acidity is too high, accompanied by pitted nickel, then

"dilute" milk of lime is added to neutralize the excess acidity. If the acidity is too low, that is, pH too high, the acidity may be increased by additions of small quantities of sulfuric acid. Even as little as a liquid ounce of 66 degrees Bé. sulfuric acid will make a large change in the pH of 100 gallons of nickel-plating solution.

If pitting is experienced when the solution has the preferred pH, this may be due to iron in the solution, and can be overcome by neutralizing, filtering and acidifying. It may be preferred, however, to precipitate the iron at the operating pH of the solution by adding small quantities of hydrogen peroxide. A suitable amount, usually about 4 to 6 ozs. of peroxide, should be accompanied by additions of sufficient acid to lower the pH to not over 4.5, in order to avoid nonadherent or curled nickel at the points of high current density.

The solution is best maintained in boric acid and nickel salts by use of a stock solution of the same formula as the main bath. Stock solution or these materials in the proper proportion are added at the end of the day, when required to restore the bath to the proper analysis. If the amount of material required is greater than that which can be added in the form of solution, the salts may be placed in a thoroughly clean burlap bag and suspended in the solution overnight. In general, additions of solid material should be avoided during working hours, and if any additions are made the nickel solution should be thoroughly stirred so that it is of uniform composition throughout and then should be allowed at least one-half hour to settle before resuming plating.

The nickel-plating solutions are filtered once a week, although the time may be lengthened if the production and actual period of the tanks has been correspondingly lightened. Before filtering the solution it should be oxidized by the addition of about one pint of commercial hydrogen peroxide for each 100 gallons of solution. Milk of lime solution is then added with agitation until the pH is increased to above 6.2. In making the milk of lime, care should be taken to see that the lime is quite thoroughly mixed with water, as the particles of lime may otherwise be coated with calcium sulfate, which will prevent the interior of the particles from acting upon the solution. A higher pH up to 6.8 is not objectionable, although attempts to reach this high value may result in the precipitation and loss of considerable nickel sulfate. One hundred gallons of solution ordinarily require about one pound of hydrated lime,

although the actual amount will, of course, vary with the condition of the solution. As the reaction takes place very slowly, it is necessary that the solution be thoroughly agitated for a considerable period of time. This ordinarily is about thirty minutes. If considerable milk of lime is put in a portion of the tank without effective stirring nickel sulfate may be locally precipitated without raising the pH in other parts of the tank.

The following factors are of use: a 1.0 normal solution of nickel contains 17.5 oz. of nickel sulfate ($NiSO_4.6H_2O$) per gallon, or 15.8 oz. of nickel chloride per gallon. A normal solution (1.0) of chloride contains 15.8 oz. of nickel chloride per gallon. A 1.0 normal solution of boric acid contains 8.33 oz. of boric acid per gallon.

Copperplating solution. This solution on analysis should show sulfuric acid 1.68 oz. normal, copper sulfate 1.68 normal.

If low in both sulfuric acid and copper sulfate, the proper additions of these materials are made. If high in both, it is necessary to discard some solution and add water. If high in one, it may be necessary to discard some solution and add water, and the material in which the bath is too low. If the solution becomes continually high in copper sulfate and in acid, it may be desirable to use some lead anodes in place of copper anodes to correct this tendency The following factors may be of use:

A 1.0 normal solution of copper contains 16.7 oz. of copper sulfate per gallon. A 1.0 normal solution of sulfuric acid contains 6.8 oz. sulfuric acid per gallon.

Addition of molasses is determined by the color of the solution. Molasses should be added from time to time to maintain a distinct greenish color to the solution, and the bath should have a molasses odor.

DEPOSITING CHROMIUM ON ELECTRIC APPLIANCES

By F. A. Maurer
Edison Electric Appliance Co., Ontario, Calif.
Delivered at Los Angeles Third Annual Educational Session, March 12, 1932

At the Ontario factory of the Edison General Electric Appliance Company we have been electrodepositing chromium over a base plate of nickel for a considerable period. The production of the plant consists at present almost entirely of electric flatirons, on which there are in general three main classifications of work to be plated, namely: (1) light small steel parts, (2) flatiron tops of

steel, (3) flatiron sole plates of cast iron. All steel parts are produced in our punch press department from stock of cold rolled steel, and in our foundry the cast iron sole plate is produced under closely controlled conditions. The cold rolled steel is bought under rigid specifications as to surface finish and defects, for we have found it pays in the end to secure a good finish on the stock. Polishing cannot be done economically when deep surface pits, roll scratches, slag inclusion or other surface defects exist. Iron of excellent quality is insisted upon from the foundry. We have two more or less opposing demands to be satisfied here. On the one hand, the machine shop requires a cast iron which will machine very easily; on the other hand, good plating presupposes a cast iron of dense small grained structure, which will be relatively impervious to the plating solutions. Balancing these two opposing requirements was an undertaking of no mean magnitude, and the way of accomplishing it is not of direct interest here. We may say, however, that the cast iron now produced analyzes—Silicon 2.40%, Sulfur 0.090%, Phosphorus 0.40%, Mn 0.60%, total Carbon 3.35%, graphitic Carbon 2.85%, combined Carbon 0.50%.

Small parts of steel are received directly into the Plating Department from the Punch Press Department, coated with drawing compound. Sole plates after machining are transferred to the Polishing Department and so are the tops. Here, with four top polishing machines, one man turns out 2700 per day. Sole plates go through the Excelsior Polishing Machine at the rate of 1000 per hour for polishing faces. Two passes are necessary, the emery size grading down on ten wheels from 60 to 120 on first pass and from 150 to 220 on second pass. Edges of sole plates are hand polished on four wheels.

In the Plating Room small parts are all handled in the following routine: clean off grease, in sawdust if light, in petroleum cleaner and sawdust if heavy. Soak in mild alkaline cleaner. Pickle if necessary, but not otherwise. Rinse thoroughly, burnish at 60 RPM with soap, 1½ hours. Dip in Trisodium Phosphate, rinse, rack, dip in acid, rinse and cyanide copperplate. Rinse thoroughly and nickel-plate in light solution at room temperature about two hours. Rinse, burnish immediately, or hold in soap until convenient to burnish, 17-70 minutes. Rinse, dry in sawdust and chrome plate.

Bolts, screws and very small steel parts are handled in like manner except nickeling is done by the barrel plating method.

Tops and cast iron sole plates are handled differently. These go direct from polishing to an electric conveyor cleaner with 10 ounces material per gallon. In 67 seconds parts are completely cleaned, tops running through as cathode, whereas sole plates run through as anode. The cleaner is the first tank of a series in the conveyor. The others in order are: Water rinse and spray, acid dip, water rinse and spray copper cleaner, water rinse. From the end of this conveyor, racked work is transferred to the nickel-plating conveyor, where in 12 minutes a plate of 0.0006″ is applied. The solution is fairly heavy and operated at about 130° at high pH. After plating, racks are transferred to a rinsing and drying conveyor, and buffing then begins. It is interesting to know that the conveyor plates 1000 per hour and that one man handles the discharge end of cleaning conveyor, loading and unloading of nickel conveyor and loading of dryer conveyor. One heavy production day of 10 hours in 1929 he handled twice 10,000 sole plates, a total weight of 50,000 pounds.

In these preliminary steps, every effort is made to secure an absolutely clean surface, chemically, on the steel and cast iron parts, and to deposit thereon a corrosion resistant, thick, and soft, ductile, deposit of nickel. To do this, of course, the base materials must be of good quality, as pointed out, and the solutions and mechanical equipment maintained in proper condition. If the nickel is not deposited as a very adherent and soft coating, it will be lifted by the internal stress of the chromium plate, which is quite high when first deposited.

Chromium plating is regulated by the rate at which work is delivered to the chromium tanks for plating. Burnished nickel is delivered direct to the chromium tanks after drying in sawdust, and plated as soon as possible without further cleaning. Cast iron sole plates and steel tops, after the cut-down buffing operation, get an additional color buffing with lime finish. Immediately after color buffing they are transferred to the chromium plating tank and plated as soon as possible. We have never attempted to run the parts through a cleaning process before chromium plating, and have had no difficulty in plating under the present system provided parts are handled within a day or two after being color buffed. An oxide coating, which develops, prevents good plating on work not handled immediately.

Each of our two tanks is lead lined with 6% antimony lead. Six per cent antimony lead anodes are used. Each tank has four compartments and the anode and cathode wiring to one compartment is independent of the other compartments, so that plating may be done in one compartment independently of the others. Thus, in one compartment we may desire to use 300 amperes at 4 volts, whereas in the one right next we may wish to use 100 amperes at 5 volts.

It requires a very high current density, from 100 to 300 amperes per square foot, to reduce chromium to its metallic state and deposit it as such. This is because chromic acid, the main constituent of a chromium plating bath, is such a strong oxidizing agent that a very large amount of electrical energy must be opposed to this oxidizing tendency to completely reduce the metal. In other words, the chromium in chromic acid is in a very high state of oxidation, and a large amount of electrical energy is required per unit of chromium metal reduced. So it is that part of the chromium, in practical operation, is only partially reduced, forming compounds in which the valence of chromium is three, instead of zero, as in metallic chromium. The chromium in chromic acid has a valence of six.

Every morning, for a half hour before running on production, steel cathodes are suspended from the cathode rod, and heavy current passed at 8 volts. This seems to get the solution mixed up thoroughly, and, we believe, is responsible in some degree for keeping down objectionable accumulation of trivalent chromium.

Occasionally a porous pot is suspended over the cathode rod, and a lead cathode suspended within the pot, which is filled with freshly made-up chromium-plating solution. No special voltage is applied, but work is run right along in the tank; the pot may stay in place several days. The purpose of the pot is to accumulate trivalent chromium within itself. The contents of the pot are thrown away after it is removed from the bath.

Every night the lead anodes are removed from the bath, occasionally they are scrubbed if yellow lead chromate accumulates on the surface. A lead anode should normally have a black coating of lead oxide; it is usually only after the anodes have remained in a bath some time, without working the bath, that the yellow lead chromate coats over their surfaces.

Iron is objectionable in large amounts in a chromium plating bath and we make every effort to prevent its accumulation.

By taking precautions such as outlined we have retained our present solutions over one year and four months, and I believe they are better right now than when first made up new. We use the solutions 8 or 9 hours per day under heavy production.

All chemicals used in various processes and all polishing and buffing supplies are bought under rigid specifications. We do not buy at the cheapest price; we determine the necessary minimum quality, buy that grade as economically as possible and insist upon receiving what we have ordered.

Under favorable conditions, with 6 men on a crew, we can turn out a tremendous amount of work. For example, we were running in one tank 384 tops per hour, and in the other tank 360 sole plates per hour—giving tops 2½ minutes and sole plates 2 minutes in the tank. Six men were required to rack, put racks into tank and remove work from racks. Smaller parts can, of course, be run at a much higher rate of output since there are from 12 to 16 per rack, and only 2 sole plates per rack. About 0.00002" thickness of chromium is ordinarily applied in from 2 to 4 minutes.

We have found it of tremendous importance to have hooks properly designed, of ample current carrying capacity, with strong spring clips to hold tight against the work, for insuring good electrical contact. We use a "stop off" lacquer on the plating hooks. Work must be arranged on the hook to prevent shading, and held at the proper angle to facilitate "slipping" of gases which, if confined, would cause pitting.

On removing work from the tank, it is thoroughly rinsed, both in a spray and in a tank of changing water, to remove chromium plating solution, then soaked in hot water for a short time to facilitate drying. When chromic acid was high in price it paid to dip plated work first into a "drag out" tank to save material, but we have eliminated this step, considering it inefficient, and a possible source of contamination.

Chromium buffing is not done unless necessary, as we find we cannot improve the luster by buffing, but are apt instead to mar the appearance under certain angles of vision. Therefore, the buffing done is a minimum.

It is, of course, well known that chromium plate is so thin that the lustre of the undercoat shines through, and that chromium plate is only as good as its undercoat. The finer the job of polishing and buffing has been, the higher the lustre of the chromium

plate. By taking advantage of this circumstance we produce several grades of chromium finish merely by changing the number of preliminary operations.

All plated ware must be of sufficient quality to withstand satisfactorily an eight-hour salt spray test. The chromium plate is so thin that it does not add to the corrosion resistance. This all comes from the nickel undercoat.

The procedure I have outlined is complicated and, of course, costly, but, we believe, the minimum necessary to produce quality plate. It is gratifying to know that even under present economic conditions there is still a good demand for quality merchandise.

GOLD SOLUTIONS FOR PRODUCTION WORK

By J. L. Merigold

Member Los Angeles Branch, delivered at the Third Annual Educational Session, March 12, 1932

Some of the gold solutions used for various finishes on jewelry and metal novelties, which I have found to be well adapted for that purpose.

There are several methods of depositing gold from its solutions —such as immersion, salt water method, salt water in conjunction with current, and with current only. The immersion and electric current methods are generally understood, but possibly the salt water method is not quite so familiar to some, so I will describe it.

A cylindrical copper tank is used having a diameter about six inches greater than the diameter of the porous jar to be used, usually of three or five-gallon capacity without any glazing. Encircling this jar is a zinc cylinder with copper lips riveted on two opposite sides and extending above the level of the porous jar. A heavy copper rod rests on these lips and crosses above the jar. The copper tank is filled with a saturated solution of salt and water and is kept nearly boiling hot by gas or other means. The porous jar is filled with the gold solution. By suspending work to be plated in the gold solution and connecting to the cross bar, a galvanic action takes place and gold is deposited. This method is usually used in plating in bulk, however. The method is slow compared to the salt water method in conjunction with the electric current. With this method use the same equipment as for salt water, except the copper bar across the jar. Connect the positive wire from the generator to the zinc cylinder and the negative to the work to be plated. The zinc cylinder encircling the

jar affords a uniform distribution of the current which is particularly desirable in plating work in baskets, and a satisfactory job may be accomplished with a minimum of metal.

It is not the object of this paper to go into details of cleaning or preparing the work before plating, it being assumed that it is understood that, whatever the finish may be, either matt or bright, the work must be absolutely clean and free from stains. No special knowledge is required for the successful operation of these solutions other than a general knowledge of plating principles. In making a solution, by drawing the gold into solution from the anode with the use of a porous cup, it is advantageous to use one-half the amount of water called for in the formula and after the desired amount of gold is in solution, to add the balance of water. The porous cup, about three inches in diameter, contains a solution of cyanide in water and is suspended in the solution, which is to be the gold solution. A spiral of heavy copper wire is placed in the porous jar and connected to the negative rod. The anode, of course, being connected to the positive rod, uses a strong current.

Following are the various formulae:

GOLD IMMERSION

1 gallon water
1 oz. caustic soda
6½ ozs. yellow prussiate of potash
8 ozs. carbonate of soda
2½ ozs. chloride of iron

Boil two hours. Then add 10 Pwts. of fine gold as fulminate and boil again. Use boiling hot in an iron kettle. Replenish by adding fulminate of gold. If solution fails to work and there is plenty of gold in it, add a very little cyanide.

ELECTRO FINE GOLD SOLUTION (Basket Work)

1 gallon of water
1 oz. cyanide
3 1/3 Pwt. of gold (as fulminate)
2 2/3 ozs. yellow prussiate of potash
1 1/3 ozs. phosphate of soda
Boil and use hot.

FINE GOLD SOLUTION—ELECTRO

½ gallon of water
4 ozs. cyanide Heat and draw.

10 Pwt. fine gold, into the solution from gold anode using electric current, with porous cup. Then add ½ gallon more of water. Use hot.

Fine Gold Solution—Electro

Dissolve 10 Pwt. fine gold in aqua-regia (2 parts muriatic, 1 part nitric), precipitate with ammonia and wash several times with hot water. (Do not allow to dry as it is then highly explosive.) Add enough water to make 1 gallon, then add 3 ozs. cyanide. Can be used hot or cold.

Fine Gold for Salt-Water Method

Stock Solution

15 Pwt. fine gold dissolved in aqua-regia and precipitated by ammonia, wash several times in hot water. (Do not allow to dry.) Add to—

12 ozs. yellow prussiate of potash
6 ozs. phosphate of soda
3 ozs. carbonate of soda
1½ ozs. sulphite of soda
½ oz. cyanide
1 gal. water

Boil 15 minutes. Replace water lost by evaporation.

Working Solution

8 ozs. yellow prussiate of potash
4 ozs. phosphate of soda
2 ozs. sulphite of soda
3 gals. water

2 cupfuls of stock solution. As solution gets weak, add stock solution.

14-Carat Shade for Salt Water Method

No. 1 *Stock Gold Solution.*

15 Pwt. ribbon gold dissolved in aqua-regia. Precipitate with ammonia and wash well. Add to the following:

12 ozs. yellow prussiate of potash
6 ozs. phosphate of soda
3 ozs. carbonate of soda
1½ ozs. sulphite of soda
½ oz. cyanide of potassium—1 gallon water—Boil 15 min.

No. 2 *Stock Copper Solution.*

1 lb. sulphate of copper dissolved in water
1 lb. yellow prussiate of potash
Mix the two and allow to settle. Wash the precipitate with several waters and add to:
12 ozs. yellow prussiate of potash
6 ozs. phosphate of soda
3 ozs. carbonate of soda
1½ ozs. sulphite of soda
½ oz. cyanide
1 gallon water
Boil 15 min.

No. 3 *Stock Cadmium Solution* (For Salt Water)

Dissolve chloride of cadmium in water. Dissolve cyanide in water and add cadmium solution until precipitate no longer dissolves. Dilute well with water.

14-Carat Salt-Water Shade

Working Solution.

6 ozs. yellow prussiate of potash
3 ozs. phosphate of soda
1½ ozs. sulphite of soda
3 gallons water
1 cupful of No. 1 stock solution
1 cupful of No. 2 stock solution
Very little of No. 3, or just enough to lighten. Use care to avoid using too much. Use hot.
If wanted YELLOW add more No. 1
If wanted RED add more No. 2
If wanted WHITE add more No. 3
If after continual use the work has a dark color, add a little cyanide.

14-Carat Shade—Electro (to be used with 14-carat anodes)

3 ozs. C. P. Cyanide
½ gal. water
10 Pwt. of ANODE run into solution by current using porous cup.
Add ½ gal. more water
It is sometimes beneficial to add 3 ozs. phosphate of soda after the solution is made. *Use hot. Strong Current.*

1, 2, 3 SHADE (used on the cheapest jewelry)

Just color articles in salt-water copper

Give a slight YELLOW CAST in salt-water gold

Give BLUSH in salt-water Cadmium. Very successful results can be obtained with this method. All solutions should contain very little metal.

GREEN GOLD—BRIGHT

½ gallon water

4 ozs. cyanide

10 Pwt. of green gold anode drawn in by current using porous cup. Then add ½ gal. more of water.

GREEN GOLD

Add chloride of cadmium dissolved in cyanide to a rich gold solution until the desired color is obtained. The above solution will deposit bright. If a rich green smut is desired add Babbitts potash. If a dark green is desired add a few drops at a time of either of the following:

No. 1. Saturate a solution of caustic soda in water with carbonate of lead by boiling.

No. 2. Saturate hydrochloric acid with arsenic by heating and while hot neutralize with ammonia and then add small piece of cyanide. Avoid fumes.

ROSE GOLD (cold)

1 gal. water

10 Pwt. gold precipitated from aqua-regia by ammonia, wash with several hot waters. Cyanide (enough to pick up gold. NO MORE). Then add (not until then).

2 lbs. sal-ammoniac

Boil hard 30 min.

Have slight acid reaction on litmus paper. If too acid add little more cyanide. If too alkali add very LITTLE MURIATIC ACID. Work will look greenish-brown when taken from solution. Now rinse in *hot cyanide,* then *reverse current,* for an *instant only,* in a fine gold solution. Relieve with bicarbonate of soda and then strike in rich fine gold solution. This gives one of the best rose golds. Some attention is necessary to keep solution neutral.

ROSE GOLD (use hot)

15 Pwt. gold dissolved in aqua-regia and precipitated by ammonia. Wash well and then add:

1 oz. cyanide

5 ozs. carbonate potash

Satin finish or sand-blast, and scratch brush, then deposit gold in above solution. Relieve with bicarbonate of soda.

ROSE GOLD (cheap on brass)

Matt dip or sand blast articles, then hang in solution following for 15 min., or until smutted:

1 lb. carbonate of copper
1 gal. muriatic acid } Allow to cool before using

Rinse well and clear color by agitating in salt water. Strike in fine gold to get base color. Relieve with bicarbonate of soda and finish in rich fine gold solution.

PURPLE GOLD (use hot)

10 Pwt. fine gold reduced to chloride and just dissolved in cyanide of potassium

20 Pwt. carbonate of copper just dissolved in cyanide

1 oz. cyanide

1 gal. water

Add arsenic (prepared as for dark green gold) a little at a time until the desired color is obtained. Used in two-color work. Some difficulty may be had at first, but is quite simple after a little experience.

BROWN GOLD (use hot)

10 Pwt. fine gold as chloride just dissolved in cyanide

25 Pwt. carbonate of copper dissolved in cyanide

1 oz. cyanide

1 gal. water

Add sufficient arsenic solution (see dark green) to produce a chocolate color. Then give slight tint in fine gold solution. Used in two-color work.

FLESH COLORED GOLD (use hot)

This is obtained in the same manner as purple gold, by the addition of arsenic, and is controlled by the operator. Used in two-color work.

GREY GOLD (use hot)

10 Pwt. fine gold as chloride dissolved in cyanide
8 Pwt. chloride of silver dissolved in cyanide
1 oz. cyanide
Add enough arsenic solution (see dark green) to make grey
Cadmium may be used instead of silver

RED GOLD (use hot)

1 gal. water
5 Pwt. of fine gold as chloride
9 Pwt. carbonate of copper
4 ozs. cyanide

WHITE GOLD (use hot)

1 gal. water
5 Pwt. of silver as chloride
4 ozs. cyanide
Cadmium may be use in place of silver. Cyanide of nickel may be used to brighten and harden deposit.

NOTE—Cyanide of nickel may be used in small quantities in any gold solution to brighten and harden deposit. When added to a cyanide copper solution it assists in brightening, hardening and delaying tarnishing.

Courtesy Conventions and Exhibitions Bureau
Philadelphia Chamber of Commerce

FRANKLIN FIELD, UNIVERSITY OF PENNSYLVANIA

BUREAU OF EDUCATION

ALBERT HIRSCH, *Chairman*

Every one is interested in the amount of money raised through the booklet

"Elementary Course In Chemical Analysis"

WELL, here is the story: out of the first hundred copies mimeographed, thirty-six copies were given free to the Branches and Officers as a sort of advertising medium to "put the thing over." The balance were sold and distributed in the following manner: five to Cleveland Branch, seven to San Francisco Branch, twenty to Los Angeles Branch, fourteen to Philadelphia Branch and eighteen through the REVIEW.

Of the twenty-seven Branches receiving free copies five Branches, Cleveland, San Francisco, Los Angeles, St. Louis and Anderson Branches are the only Branches that discussed the Course at their meeting and reported it through the REVIEW.

The moneys received for the first one hundred copies to date approximately meets the Bureau's expense for the past two years. Thus leaving nothing for the Research Fund.

Five hundred additional copies would cost $136.00 and if sold through the Branches would net about $300.00 for the Research Fund.

No attempt to print another edition of the Course will be made unless the Bureau is requested to do so by the members and Branches.

Many favorable comments on the Booklet have come to the Bureau. Therefore we suggest all members having received a copy please write to the Bureau telling in your own way what you think of it.

BRANCH NEWS

LOS ANGELES BRANCH

Third Annual Educational Session and Dinner Dance

In a setting of brilliance such as is made available only in the beautiful Gold Ballroom of the Alexandria Hotel, the members of the Los Angeles Branch, their friends and guests, assembled on Saturday evening, March 12. The Third Annual Dinner Dance held by the Branch was far better than the previous affairs, not only as to the surroundings, but also in point of attendance and profit as well; and when we say profit we don't means just dollars, but educationally and socially, because the Educational Session in the afternoon was very well attended and the papers presented were very much above the average and a number of new ideas were brought out.

The discussions proved that those present were deeply interested and repaid for the effort they made to be present. The evening was fragrant with an atmosphere of social get-together, pretty much like a large family, and the memory of the affair will linger long with all those present, because of the reluctance to leave at the close of the evening, when some danced their last dance over five or six times. They just did not seem to feel like parting with the scene or the people with whom they had formed new ties of friendship, which we hope will grow throughout the years.

There were no exhibits this year other than the prizes on display gratuitously contributed to the Branch by members and firms interested in the plating industry.

The following were the donors and winners.

Donor	*Winner*
Maas Waldstein Lacquer Co.	E. Lamoureux
Edison Gen. Elec. App. Co.	H. H. Woodward
U. S. Spring Bumper Co.	R. F. Magnus
Turco Products, Inc.	Distributed
Cal. Brass Mfg. Co.	S. A. Richmont
S. & M. Lamp Co.	E. P. Robinson
Repcal Brass Mfg. Co.	Mrs. E. Crooks
Price Pfister Brass Mfg. Co.	T. Kreuder
Palace Plating Co.	Geo. Kyle
Oakite Products, Inc.	Distributed
National Chemical Co	C. Dennis
Liberty Electro-Plating Co.	Mrs. E. Lamoureux
Stauffer Chemical Co.	E. P. Robinson
American Die Casting Co.	Gertrude Rynkofs
American Die Casting Co.	F. E. Shaw
American Die Casting Co.	G. Aballi
Agate Lacquer Mfg. Co.	Favors for all ladies
J. B. Ford & Co.	H. Marmer
W. E. Hurd	Mr. Fuller
W. E. Hurd	Mrs. Fuller

Some of the more distinguished guests at this year's banquet were more or less noticeable, for instance:

Old Man Notgnihtrow, as he is affectionately called by his friends, surely had the time of his young life, a careful check showing that he did not miss a single dance. Oeg. Elyk's luck has changed; he won a prize, a beautiful airplane ash-tray, and now he can save money by staying away from the movies and smoke at home. Ppirg, Llissur, former librarians, Nod Llewdeb, and a few others were particularly noticeable by the reflection of their bald domes, said to be caused by general plating business in Los Angeles.

F. C. Nothsur made a good job of being Master of Ceremonies, and distributor of prizes. As a bridge player Einre Sicnarf felt he was a perfectly good plater. Valentino in his palmy days never had a thing on our friend Nosnibor as a dancer; in fact we heard Eibbor had thought of taking up the art as a profession, that is if he can obtain a contract in the movies. We understand Lrac Sinned is quite a cleaner salesman, and wonder how he will dispose of the cleaner product of a competitor he won in the raffle. Speaking of raffles, dramatically, Sfoknyr was here and there and all over the place, but always turned up with a bunch of money. They say it is a habit with him. Ecnerale Notnroht thought the Fresno Turkey Dinner was great. We were unable to secure any explanation of his many visits to the kitchen. For your convenience if you spell the above names backwards it may help you to recognize some of the eastern old timers on the Pacific Coast.

At the Educational Session the following papers were presented by their authors:

"Gold Solutions for Production Work"—J. L. Merigold.

"Hot Nickel Solutions and Low pH"—A. Regmunt, U. S. Bumper Co.

"Deposition of Chromium on Electric Appliances"—F. A. Maurer, Edison Elec. App. Co.

"Job Shop Practice"—R. U. Gripp, Russell Plating Works.

"Some New Thoughts on Electrolysis"—Dr. S. Fisher, Los Angeles Board of Education.

"Summary of Research at U. S. Bureau of Standards"—J. P. Strauser, Washington, D. C. Delivered by E. Lamoureux.

"Question Box Forum"—Earl Coffin, Librarian.

Owing to lack of time, the Question Box Forum was not taken up for discussion. Same will be brought up at the April meeting.

M. D. Rynkofs, *Secretary.*

DETROIT BRANCH

The April meeting of Detroit Branch was well attended and an interesting program was submitted by the Committee on Education.

Mr. Arthur G. Spencer and Mr. H. J. Jamieson presented microphotographs of various deposits, showing the structure and thickness of the metals deposited. Both gentlemen explained how and why the photos were made and what may be learned from them.

The Educational Committee is preparing a program for the May meeting that will give us a view of the progress made in tin plating. Mr. Wm.

M. Phillips and Mr. Chas. Eldridge are aiding the committee to get speakers for this meeting.

One of the most gratifying features of our meetings during the past winter was the increasing attendance of our members at them, and we feel confident that it will continue, and the interest of the meetings will keep step with the increasing attendance.

Owing to the length of the program, the Question Box was postponed until next meeting.

We hope there will be a very large attendance at our next meeting on May 6 as the annual election of officers takes place then.

GEO. KUTZEN, *Secretary*

WATERBURY BRANCH

The regular monthly meeting of Waterbury Branch, A. E. S., was held in Engineers Hall, Friday evening, April 8th. President Leroy Miller presided over a well attended meeting. Communication was received from Walter Fraine, treasurer of the Research Committee, acknowledging the receipt of a check for $80.00; same being a donation from the local Branch to the research fund of two dollars a member. An interesting report of the activities of the chemistry class was submitted by Ellsworth Candee and Earle Couch, who were in charge. During the season the class covered the following subjects: Equivalent Weights, Normal Solutions and the following determinations: Acid, Alkali, Copper, Nickel, Chloride, Tin and Zinc. A table of standard solutions was made up so that in titrating there would be no calculations required. The instructors stated that many thanks were due Henry Mahlstedt and Spencer L. Heun for the assistance they rendered. Chairman Miller called the members' attention to the annual meeting which will take place Friday evening, May 13. As the election of officers and other important business will take place on this occasion, it is desired that all members who possibly can, attend.

WM. F. GUILFOILE, *Secretary.*

HARTFORD-CONNECTICUT VALLEY BRANCH

The Hartford-Connecticut Valley Branch, A. E. S., held their regular monthly meeting on Monday evening, March 28, at the Hartford Chamber of Commerce.

The meeting was called to order at 8:30 p.m. with Pres. Fleming in the chair. Minutes of the previous meeting were read and approved. One communication was read. One application was received for active membership, the applicant being Mr. Norman Mosesian of Norwich, Conn. It was voted for the application to take the usual course.

There being no speaker for the evening, the time was spent in the planning of the details in the preparation of our annual educational session and banquet, to be held on Saturday afternoon and evening of May 14, 1932, at the Hotel Bond, Hartford, Conn.

Various committees were appointed to take charge of the affair, and no labor or expense is to be spared to make the affair a success.

No further business being brought up, the meeting adjourned at 10.00 p.m.

V. E. GRANT, *Secretary.*

BOSTON BRANCH

Boston branch met Thursday, the 7th, at the American house with President Gale in the chair.

After the regular order of business of reading of the minutes, communications, bills and reports of committees one new member was elected to membership and two new applications were received for membership, and also the transfer of one member of New York Branch, Wm. P. Manning, to Boston Branch. The meeting was then turned over to the librarian, Mr. Mackie.

There being no questions for the box Mr. Mackie had as the speaker of the evening one of our new members, Mr. Arthur J. Mintie. His subject was "Barrel Plating." He gave one of the best talks heard by the members of this branch in a long time. He explained the construction of the barrels, of the different solutions used, the time for plating, and how to keep the solutions up to the standard, and also gave some of the formulas of the solutions used. Mr. Mintie had some of the samples of rivets done in these barrel solutions and were the finest that some of the members have ever seen.

He answered all questions and was given a vote of thanks for his very interesting talk.

The meeting adjourned at 10.30 p.m. A. W. GARRETT, *Secretary.*

CLEVELAND BRANCH

Cleveland Branch held its monthly meeting Saturday evening, April 2, at Hotel Winton, President E. Steen Thompson presiding.

A telegram was read telling of the death of our fellow member, Mr. Richard Sliter, at Masonic Home, Burlington, N. J. The Chair suggested we observe a moment of silence in respect for our departed member.

The minutes of the February meeting were approved as read. Mr. Zadowski gave a report on the Chemistry Class. The lessons have been copied and are being sent to each member.

Mr. Singler gave a demonstration of the tri-chloracetic acid test for nickel on brass, telling of his difficulties in getting nickel to stand this test. After considerable work it was found that by cleaning the work better, a more homogeneous plate was obtained and that it would stand the test.

Our May meeting will be held at the plant of the Columbia Electric Co. Mr. Cyrex will be our host and we hope to get out a good crowd.

PAUL STAMM, *Secretary.*

MILWAUKEE BRANCH

The regular meeting of Milwaukee Branch was held April 14, 1932, at Lipps Hall, Third and West Highland Ave. Vice Pres. Paul Krause called the meeting to order. The smoker committee reported it has a very good educational program, having six excellent papers. After the regular order of business nomination of officers for the coming year. The following were nominated: For Pres., Paul Krause and M. Nishwitz; for Vice-Pres., Art Koehler, Robert W. Shaffer and H. C. Jaeger; for Secy. Treas., Frank J. Marx; Librarian, Henry Binder and Asst. Lib., Henry Hurtig; for Board of Mgrs., Robt. Steuernagel, Dan Wittig, Jack Geissman, Ed. Werner and

Adolph Brown. The meeting was well attended. The chemistry class will close on April 20 with a dinner given by the instructor, M. F. Colien. The class will get going again in September.

FRANK J. MARX, *Secretary-Treasurer.*

ANDERSON BRANCH

The meeting was called to order at 8 o'clock p.m., March 7, in the Anderson Y. M. C. A.

The following officers were absent: Messrs Kaegi, Sanders, and Wagner.

Minutes of the February meeting were read and approved.

A letter from Mr. Tunbeck requesting papers from active members for the Convention in June was read, and Mr. Cleaver discussed this matter.

A bill from the Supreme Society for Fourth Quarter per capita tax was read and ordered paid.

Mr. Cleaver announced the appointment of Ed Kaegi as general chairman for the Annual Banquet.

There being no further business, the speaker of the evening, Mr. P. C. Smith, Supervisor of Polishing at Guide Lamp Corp., was introduced. Mr. Smith presented a very interesting talk on "The Polishing and Buffing of Brass for Plating."

Discussion was invited and several questions were asked, which Mr. Smith answered.

Mr. Gail Eldridge, new associate member from Indianapolis, was introduced. Other guests present who were introduced included Mr. Emmett and Mr. Lewis of the Rex Products Co., and Mr. A. W. Hutton of the Cowles Detergent Co.

Mr. Cole then gave a very interesting summary of an article, entitled "Degreasing by the Vapor Process."

Mr. Emmett and Mr. Lewis gave a discussion of the Rex method of degreasing. Questions were asked by Mr. Onksen, Mr. Cleaver, Mr. Wilson, Mr. Cole, Mr. Phelps, and Mr. Eldridge.

Mr. Hutton then spoke briefly describing the Hobart method of removing compound by immersion in hot paraffin oil.

After several questions on this process, the meeting adjourned at 9.55 p.m.

G. S. COLE, *Acting Secretary.*

The meeting was called to order at 7.45 p.m., April 4, at the Anderson Y. M. C. A.

Roll call of officers showed Mr. Phelps absent.

Minutes of the March business meeting were read and approved.

A bill for 500 invoices from the Short Printing Co. was approved and ordered paid.

Announcement was made of the receipt of a report from the Bureau of Standards on the preparation of specimens for exposure tests of electroplated coatings on steel.

The application of Mr. G. M. Cole, of Delco-Remy Corporation, was read and Mr. Cole elected as an active member, following a favorable report by the committee.

The treasurer made another appeal for dues which netted some return.

Mr. Cleaver announced the following committees to assist Mr. Kaegi, General Chairman, in making preparations for the Annual Banquet:

Program and Entertainment—R. M. Wagner, G. S. Cole.

Food and Refreshments—F. E. Hammond, E. A. Rhodes.

Tickets—A. W. Phelps, G. W. Onksen, G. Wilson, C. H. Bonge, Jr.

Mr. Kaegi announced that those committee members present would hold a meeting following the regular Branch meeting.

Mr. Cleaver announced that it would be proper to elect delegates to the Philadelphia Convention at the next regular meeting, and urged those members who expected to attend to turn in their names in order that we might be assured of having delegates who could attend.

There being no further business, the meeting was turned over to Mr. D. A. Cotton, who presented a very interesting discourse on "Acid Copper Plating." Notes on this talk were distributed to the members following the talk and discussion.

The meeting adjourned at 9:45 p.m.

R. M. WAGNER, *Secretary-Treasurer.*

CHICAGO BRANCH

The regular monthly meeting of Chicago Branch, A. E. S., was held Saturday, April 9, 1932, at the Atlantic Hotel.

The meeting was called to order with President J. C. Kretschmer presiding and all officers present.

Mr. Jelnik of the Edison Elec. Appliance had a wonderful display of two-tone chrome-plated stainless steel.

Two-tone produces some amazingly beautiful effects; stainless steel can be made more durable and beautiful by chrome plating.

Chicago Branch will hold its Annual Booster Meeting Saturday, June 11, 1932, at the Atlantic Hotel and as this is also the 20th Anniversary year of the Branch, we bid all members of the Branch to attend and all A. E. S. members that are in the vicinity are all welcome to attend.

We regret to receive the transfers of Mr. E. Lamoureux who now resides in California. And Mr. P. R. Lyons now in Cleveland.

The business part of the meeting having been taken care of, the meeting was turned over to the Librarian, Mr. O. E. Servis, and the following questions were found in the Box:

Question—Can Trivalent Chromium be formed in a lead lined tank equipped with antimony lead anodes, Bath operated at 120°F?

Answer—This question brought out some interesting arguments.

Question—Has any of the members had any experience in plating Brass with a slight percentage of antimony? This copper zinc antimony alloy is to be applied to steel.

Answer—Would like to hear from other Branches.

E. G. STENBERG, *Secretary.*

ST. LOUIS BRANCH

Our Get-Together Party was held at the American Annex, Saturday, April 9, 1932. Dinner was served at 1.15 p.m. After enjoying the meal Mr. Williams opened the meeting by asking all present to introduce themselves, after

which he explained that this was taking the place of the regular banquet and thanked all the members and friends of St. Louis Branch for turning out for this affair.

Mr. B. Daw was the first called and gave a very good talk on the practical side of chromium plating, told about some of the large plants and the good results they were getting in chromium plating and some of the difficulties they were having. His talk was enjoyed by all. Then a lively discussion was held by all joining in and some good suggestions were offered.

Dr. Stout of Washington University was next called on. His subject was: Diagnosis and Corrections of Faulty Solutions. Dr. Stout spoke about analyzing solutions and said that in making analysis one should not take the top layer, but should stir solution, let settle and then take sample of solution for analysis and you can note the results, as every layer would analyze different. After his talk quite a number of questions were asked, which were answered to satisfy all. Mr. Williams then thanked Dr. Stout and Mr. Daw for the interest and time given the educational program for the St. Louis Branch, after which meeting adjourned.

CHAS. T. MCGINLEY, *Secretary.*

APPLICATIONS

GUY M. COLE, 104 Beverly Terrace, Anderson, Indiana (Active) Anderson
WALTER FRANKLIN, 279 Locust Street, Dover, N. H. (Active).....Boston
EDWARD C. DE LORME, 39 Park Street, Wollaston, Mass. (Active)....Boston

ELECTIONS

GUY M. COLE, 104 Beverly Terrace, Anderson, Indiana.....Anderson
ARTHUR J. MINTIE, 50 Channing Street, Wollaston, Mass. .....Boston

SUSPENSIONS

GEORGE C. LEACH, 46 New Cross Street, Somerville, Mass. .....Boston
E. GESSER, 7915 E. Lafayette Street, Detroit, Michigan.....Detroit
H. WEIMAN, 648 Mt. Vernon St., Detroit, Michigan.....Detroit
E. RITTER, 3741 Maxwell Avenue, Detroit, Michigan.....Detroit
GEO. RAAB, 3204 Helen Avenue, Detroit, Michigan.....Detroit
M. LONGWORTH, Box 250, Chelsea, Michigan.....Detroit
A. C. HOFFMAN, 5760 Lowell Avenue, Indianapolis, Indiana.....Indianapolis

REINSTATEMENTS

GEO. M. ROBERSON, 49 River Street, Hoosick Falls, N. Y. .....New York

DEATHS

MR. RICHARD SLITER, a member of the Cleveland Branch.

TRANSFERS

E. LAMOUREUX from Chicago to Los Angeles Branch.
P. R. LYONS from Chicago to Cleveland Branch.
ELMORE R. FAHY, 323 King Avenue, Detroit, Michigan.....Detroit
JOHN HERBERT JENKINSON, 673 Turner Road, Walkerville, Ontario, Canada

NOTICE

J. S. Nachtman, Warren, Ohio, changed from associate to active membership in Cleveland Branch.

RESEARCH COMMITTEE

Chairman, JACOB HAY.....6920 Ottawa Ave., Chicago, Ill.

Sec.-Treas., WALTER FRAINE.....507 Grand Ave., Dayton, Ohio

S. E. HEDDEN.....227 Fifth Ave., Aspinwall, Penn.

WILLIAM F. GUILFOILE.....14 Oakland St., Waterbury, Conn.

DAN WITTIG.....1221 N. Third St., Milwaukee, Wis

DR. WILLIAM BLUM.....Bureau of Standards, Washington, D. C

MR. OSCAR SERVIS.....5305 Warner Ave., Chicago, Ill

MR. N. E. ZADOWSKI.....1383 W. 65th St., Cleveland, Ohio

MR. W. S. BARROWS.....628 Dovercourt Road, Toronto, Canada

C. F. NIXON.....Ternstedt Manufacturing Co., Detroit

DR. H. S. LUKENS.....University of Pennsylvania, Philadelphia, Pa.

BUREAU OF EDUCATION

Chairman, MR. ALBERT HIRSCH.....1945 Airdrie St., Philadelphia

Branch Representatives:

Chicago Branch.....HAROLD FAINT

Waterbury Branch.....ELLSWORTH CANDEE

Los Angeles Branch.....M. D. RYNKOFS

New York Branch.....HENRY LEVINE

Philadelphia Branch.....DR. A. K. GRAHAM

Baltimore-Washington Branch.....DR. WM. BLUM

Cleveland Branch.....J. C. SINGLER

Hartford-Connecticut Valley.....RAY O'CONNOR

Worcester Branch.....M. H. FROMMANN

Toronto Branch.....C. KEMESH

Anderson Branch.....D. A. COTTON

Newark Branch.....PAUL A. OLDAM

Milwaukee Branch.....HENRY BINDER

St. Louis Branch.....H. H. WILLIAMS

Other Branch Representatives will be printed as received.

ANDERSON BRANCH

Meets first Monday of every month at 7:30 p.m. at the Anderson, Indiana, Y. M. C. A. R. M. Wagner, Secretary-Treasurer, 28 W. 12th St., Anderson, Indiana.

BALTIMORE-WASHINGTON

Meets in Enoch Pratt Library, Calhoun and Hollis Sts., Irvin H. Hahn, Secretary, 207 S. Sharp St., Baltimore, Maryland.

BOSTON

Meets at American House, Boston, Mass. First Thursday each month. Secretary, A. W. Garrett, 100 King St., Dorchester, Mass.

BRIDGEPORT

Meets first and third Friday of each month at Chamber of Commerce Rooms, Stratfield Hotel. Secretary, T. H. Chamberlain, 859 Orange St., New Haven, Conn.

CHICAGO

Meets second Saturday of each month, at 8 p.m., Atlantic Hotel, 316 S. Clark St., Secretary, E. G. Stenberg, 2200 N. Kenneth Ave., Chicago, Ill.

CINCINNATI

Meets every Thursday, 7.30 p.m., at Vocational Training School, Spring and Liberty Sts. Secretary, Al Yeager, 2021 Sherman Ave., Norwood, Ohio.

CLEVELAND

Meets first Saturday of each month at Hotel Winton. Paul R. Stamm, Secretary, 947 Elbon Road, Cleveland Heights, Ohio.

DAYTON

Meets first Saturday of each month at the Y. M. C. A., Dayton, Ohio. Secretary, Ward Protsman, 141 Westwood Ave., Dayton, Ohio.

DETROIT

Meets the first Friday of each month at the Hotel Statler, Louis II Room. Secretary-Treasurer, George Kutzen, 1087 State Fair Ave., West Detroit.

GRAND RAPIDS

Meets second Thursday of each month, 7.30 P. M., at Cody Hotel, 1 Division Avenue, South. Secretary, Jacob Van Dyke, 1361 Union Ave., N. E., Grand Rapids, Mich.

HARTFORD-CONNECTICUT VALLEY

Meets fourth Monday in each month alternately at the Chamber of Commerce, 815 Main St., Hartford, and the Chamber of Commerce, 134 Chestnut St., Springfield. Secretary, Vernon Grant, 32 Jennings Road, Bristol, Conn.

INDIANAPOLIS

Meets second Saturday of each month at Hotel Denison. Secretary, Louis Mertz, 1725 Union St., Indianapolis, Ind.

LOS ANGELES

Meets second Wednesday of each month at the Chamber of Commerce Bldg., 9th floor, 1151 S. Broadway. Secretary, M. D. Rynkofs, 1354 W. 25th St., Los Angeles, Calif.

MILWAUKEE

Meets second and fourth Thursdays of each month at Cor. 3rd and Highland Ave., Frank J. Marx, 1431 W. Cherry St., Milwaukee, Wis.

MONTREAL

Meets second and fourth Friday of ea month at 1437 Aylmer St., Montreal, Queb Canada, where the Secy-Treas., Mr. Char Doherty, can be found at any time.

NEWARK

Meets first and third Fridays of ea month at Newark Elk's Club, Broad S Newark, N. J., at 8 p.m. Secretary-Trea urer, Geo. Rueter, P. O. Box 201, Newar N. J.

NEW YORK

Meets second and fourth Fridays of ea month in the World Building, Park Ro New York City, N. Y. Secretary-Treasure J. E. Sterling, 2581 46th St., Astoria, L.

PHILADELPHIA

Meets first Friday of each month in th Harrison Laboratory Building, University o Pennsylvania, 34th and Spruce Sts. Secretar J. E. Underwood, 327 N. 10th St., Camde N. J.

PITTSBURGH

Meets first Friday of each month at 8 p.m. at downtown branch, Y. M. C. A. Secretary S. E. Hedden, 227 Fifth St., Aspinwall, Pa.

PROVIDENCE-ATTLEBORO

Meets first and third week of each month. Notice by card. J. H. Andrews, Secretary, 19 Rosedale St., Providence, R. I.

ROCHESTER

Meets third Friday of each month at Hotel Seneca. Secretary, Chas. Griffin, 24 Garson Ave., Rochester, N. Y.

SAN FRANCISCO BRANCH

Meets at Plaza Hotel, San Francisco. Secretary, H. W. McKibben, 310 Tehama St., San Francisco, Cal.

ST. LOUIS

Meets second Friday of each month at the Plant of the Lassalco Co., 2828 LaSalle St. Secretary, C. T. McGinley, 8214 Fairham Ave., University City, Mo.

TOLEDO

Meets first Thursday of each month at Toledo Secor Hotel, Cherry and Page Sts. James M. Lee, Secretary, Barker Street, Fremont, Ohio.

TORONTO

Meets fourth Monday of each month at Canadian Foresters' Hall, 22 College St., Room No. 2. Secretary, H. W. Graham, 101 Robina Ave., Toronto, Canada.

WATERBURY

Meets second Friday of the month at Engineers Hall, No. 11 East Main Street. Wm. F. Guilfoile, Secretary, P. O. Box 961, Waterbury, Conn.

WORCESTER

Meets Directors' Room, Chamber of Commerce, Worcester, Mass. Roger H. Bryant, Secretary, 94 Grove St., Worcester, Mass.